Benchmark Study

– Establishing Details, Data Disaggregation

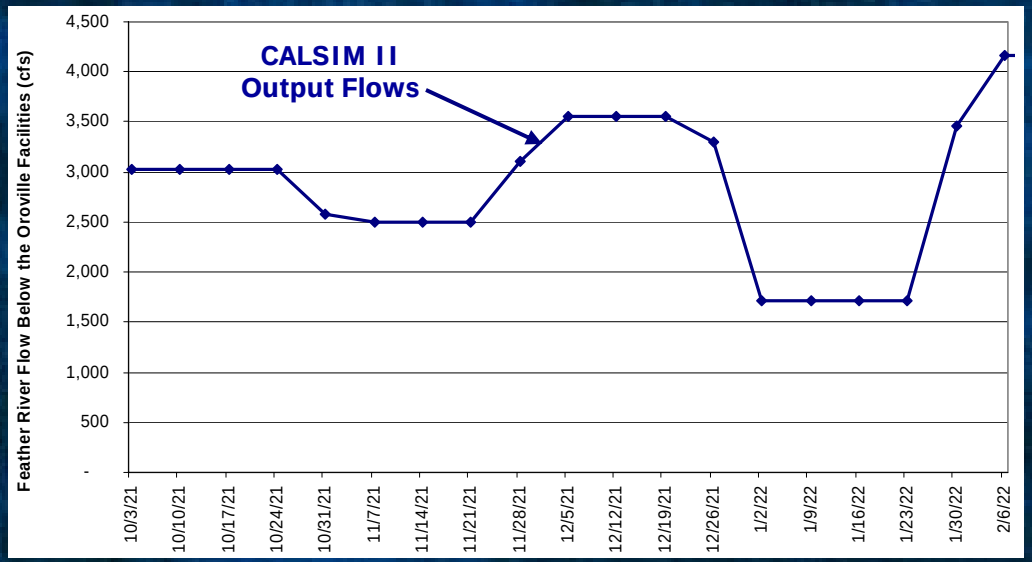
- Data Disaggregation:

  A consistent, systematic methodology to transform monthly CALSIM II data into weekly data for HYDROPS input

Benchmark Study

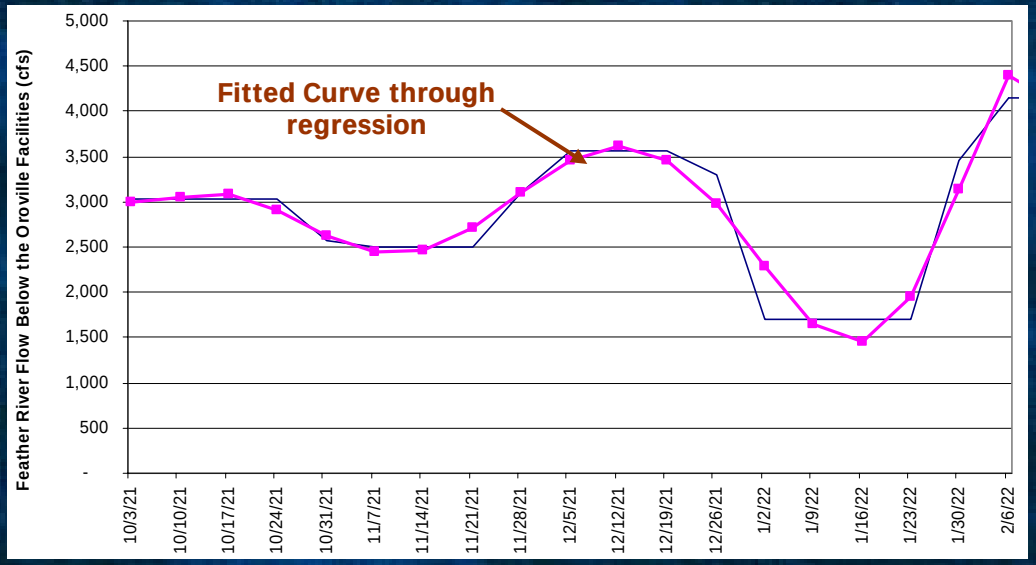
– Establishing Details, Data Disaggregation

- Generates a "stepped" curve for the weekly Feather River flows
  - Assign CALSIM II monthly output for the Feather River below the Oroville Facilities to each day of a month
  - Calculate average daily values for each week



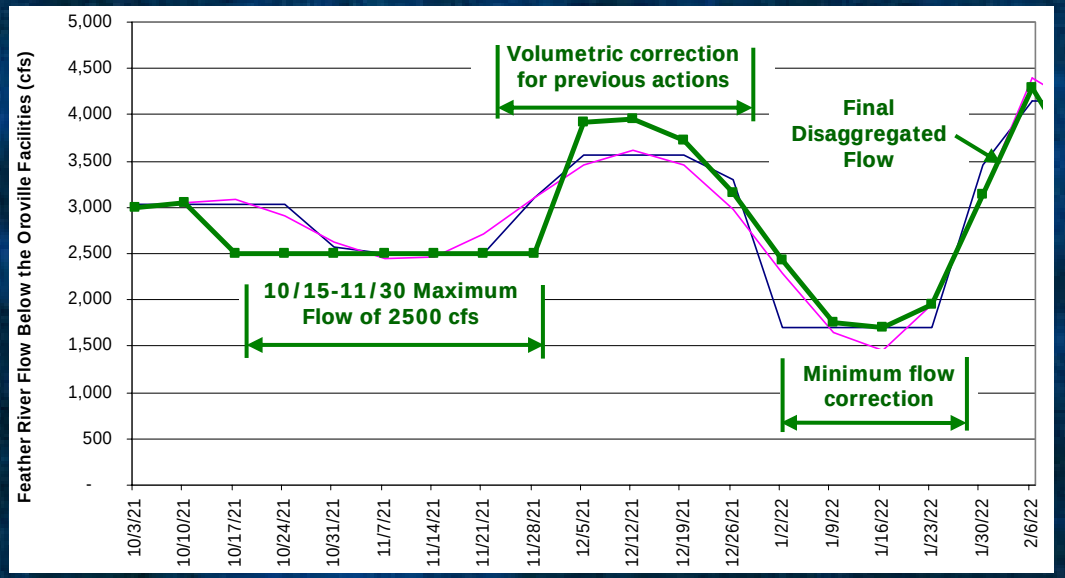
Benchmark Study
– Establishing Details, Data Disaggregation

- Apply data smoothing process to the entire 3,800-week simulation period
  - Generate a polynomial curve to represent weekly flows in a period of 15 to 20 weeks
  - Use two to three weeks of overlap between regression periods to ensure a smooth transition



Benchmark Study
– Establishing Details, Data Disaggregation

- Correct regression curve to incorporate:
  - Flow Requirements
  - Ramping criteria for fishery considerations
  - Ramping criteria for high flow periods
  - Maximum storage consideration
  - Removal of volumetric error accumulated through the above actions



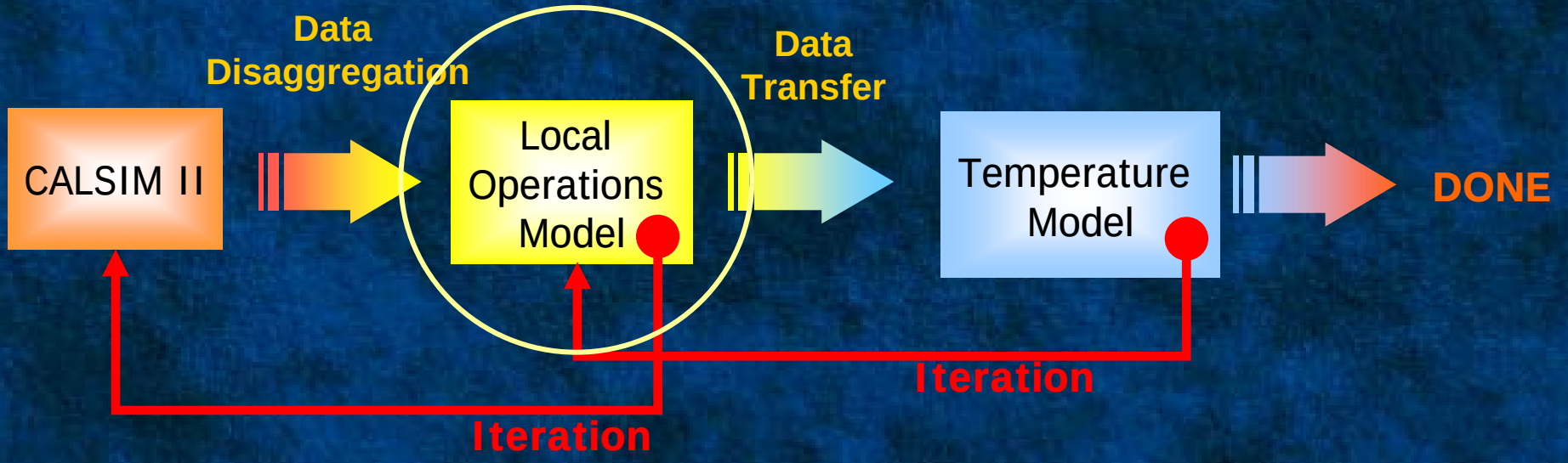
Benchmark Study

– Establishing Details, Data Disaggregation

- Lake Oroville storage and releases are modified to reflect the revised weekly Feather River flows below the Oroville Facilities
  - Data series is reviewed and approved by DWR Operations staff
  - Data is exported as input file for HYDROPS

Benchmark Study

– Establishing Details, HYDROPS



- Water supply conditions
- Monthly operations and water budget

- Power generation
- Hourly operations

- Reservoir temperature
- River temperature
- Ag diversion temperature

Benchmark Study
– Establishing Details, HYDROPS

- Basic model development
  - Presented in Workshop #1
- Tuning the simulated operation
  - Iterative process through collaboration of SWP Operations and modeling team
  - Simulated Operations within the boundary defined by CALSIM II/Disaggregation
  - Incorporate operation changes for temperature control actions identified by using WQRRS (This has not been done yet.)

Benchmark Study
– Establishing Details, HYDROPS

- Major Assumptions
  - Weekly input from CALSIM II/Disaggregation
    - hydrology, diversions, Feather River flow below Thermalito Afterbay outlet, and target reservoir levels
  - Physical facility limitations
    - Including detailed specifications for individual turbine and river valve
  - Feather River flow below Thermalito Afterbay outlet
    - Hourly conditional ramping criteria
    - Maintaining constant flow during the week, if possible

Benchmark Study
– Establishing Details, HYDROPS

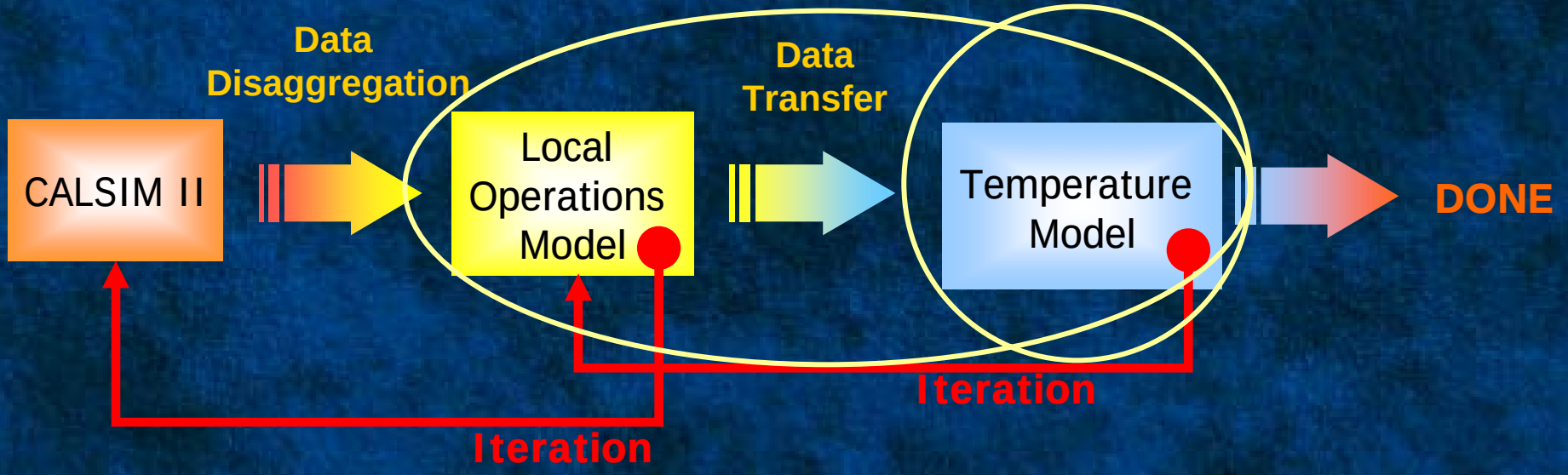
- Major Assumptions (cont'd)
  - Annual energy price by hour
    - Based on the average of CEC projection for 2004-2033 period
    - Uniformly applied to all years in simulation period
  - Pump-back trigger
    - Difference between on- and off- peak energy prices is more than 21 percent
      - Considers unit startup cost and efficiency

Benchmark Study
– Establishing Details, HYDROPS

- Review/Validation
  - Model results (before handoff to WQRRS) were reviewed by DWR operations staff
  - Simulated results are reasonable
    - Generation was comparable with current practice
    - Pump-back was higher compared with current practice (expected to be comparable in final results)

Benchmark Study

– Establishing Details, WQRRS



- Water supply conditions
- Monthly operations and water budget

- Power generation
- Hourly operations

- Reservoir temperature
- River temperature
- Ag diversion temperature

Benchmark Study
– Establishing Details, WQRRS

- Basic model development
  - Presented in Workshop #1
- Tuning the simulated temperature conditions
  - Simulated operations within the boundary defined by CALSIM II/Disaggregation
  - Iterative process to incorporate operations for established temperature objectives (temperature control actions)

Benchmark Study

– Establishing Details, WQRRS

- Established Temperature Objectives
  - Fish Hatchery

Frequently Controlling Objective

Period	1	2	3	4	5	6	7	8
From	1-Sep	1-Oct	1-Dec	1-Apr	16-May	1-Jun	16-Jun	16-Aug
To	30-Sep	30-Nov	31-Mar	15-May	31-May	15-Jun	15-Aug	31-Aug
Temperature Objective (degree F)	52	51	55	51	55	56	60	58

1. Temperature objective is defined on a daily-average basis.
2. During April through November, a tolerance range of 4 degrees is allowed, but not modelled.

  - Low Flow Channel

Period	1	2	3	4	5	6	7	8
From	1-Sep	1-Oct	1-Dec	1-Apr	16-May	1-Jun	16-Jun	16-Aug
To	30-Sep	30-Nov	31-Mar	15-May	31-May	15-Jun	15-Aug	31-Aug
Temperature Objective (degree F)	65	-	-	-	-	65	65	65

1. Temperature objective is defined on a daily-average basis.
2. The requirement is not intended to preclude pump-back operations needed to supply energy during periods when the California ISO anticipates a Stage 2 or higher alert.

Benchmark Study
– Establishing Details, WQRRS

- Temperature Control Actions
  - Fish Hatchery

- Pull shutters
  Iterations using WQRRS
- Reduce pump-back operations
  Iterations using WQRRS with post-processed HYDROPS flows
- Reduce peaking generation
  Iterations using WQRRS with post-processed HYDROPS flows
- Open River Valves to mix cooler water with warmer penstock water
  Iterations using WQRRS with post-processed HYDROPS flows
- Stop power generation; release from River Valves only
  Iterations using WQRRS with post-processed HYDROPS flows

Benchmark Study
– Establishing Details, WQRRS

- Temperature Control Actions
  - Low Flow Channel

Need colder water

- Increase Thermalito Diversion Dam Power Plant flow
  Iterations using WQRRS with post-processed HYDROPS flows
- Open Thermalito Diversion Dam gates and increase flow by 100-cfs increments until flow in the Low Flow Channel reaches 1,200 cfs
  Iterations using WQRRS with post-processed HYDROPS flows
- Pull additional shutters
  Iterations using WQRRS
- Use of River Valves may be considered
  Iterations using WQRRS with post-processed HYDROPS flows

Benchmark Study

- Establishing Details, Status

- Status: Near Completion

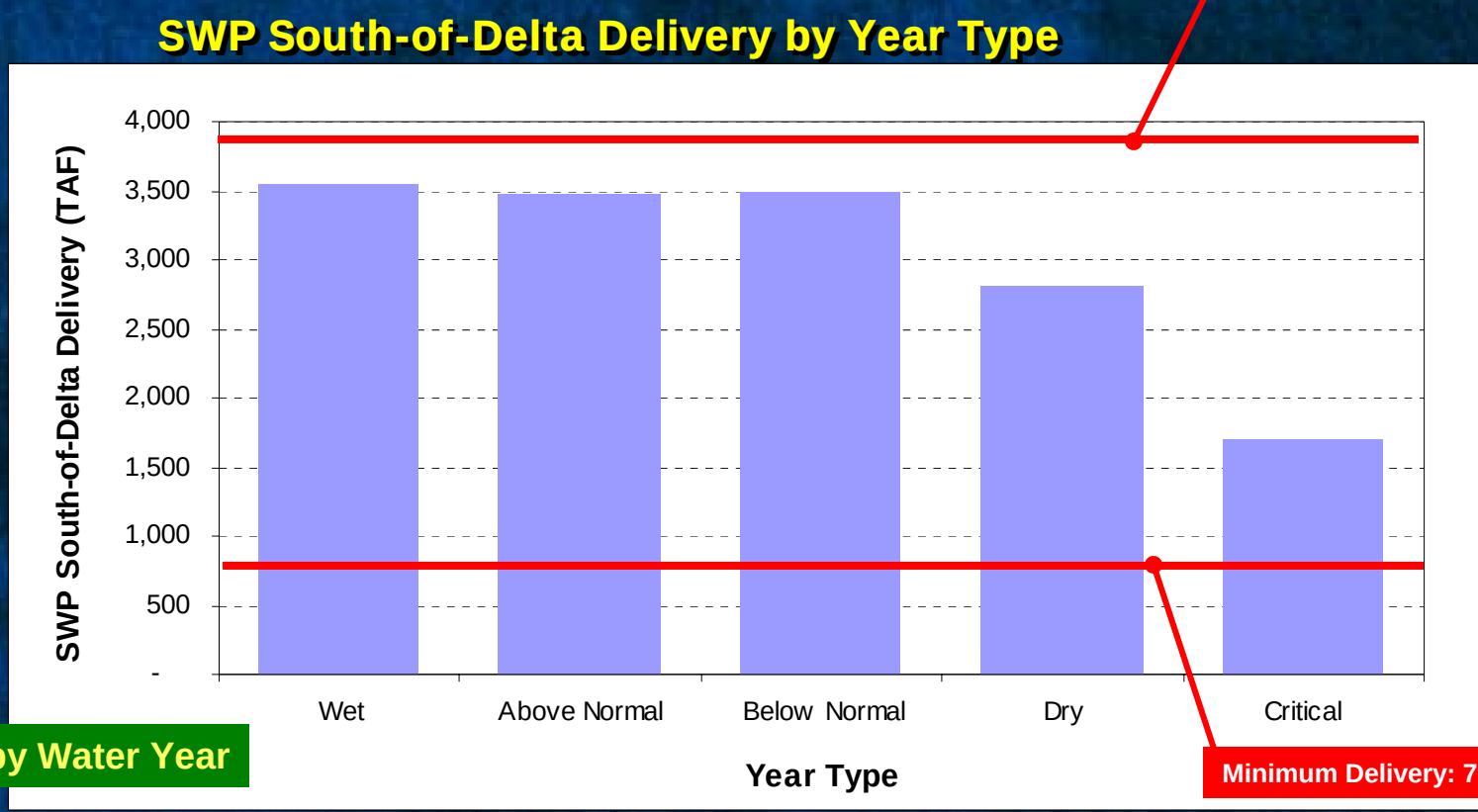
	CALSIM II	HYDROPS	DWR Review	WQRRS	Operation Changes
First Iteration					
1922 - 1936	Completed	Completed	Completed	Completed	Identified
1937 - 1952	Completed	Completed	Completed	Ongoing	–
1953 - 1967	Completed	Completed	Completed	Ongoing	–
1968 - 1982	Completed	Completed	Completed	Ongoing	–
1983 - 1994	Completed	Completed	Completed	Ongoing	–
Second Iteration					
1922 - 1936	Unnecessary	–	–	–	–
1937 - 1952	Unnecessary	–	–	–	–
1953 - 1967	Unnecessary	–	–	–	–
1968 - 1982	Unnecessary	–	–	–	–
1983 - 1994	Unnecessary	–	–	–	–

Benchmark Study Results
– Existing Conditions

- Results Summary
  - Water supply
    - SWP allocation
  - Power generation
    - Annual power generation with Pump-Back percentage
    - On/off peak comparison
    - Monthly pattern with Pump-Back percentage
  - Temperature
    - Agricultural diversions in Afterbay
    - River temperature at Robinson's Riffle
  - Reservoir Levels
    - Memorial day
    - Independence Day
    - Labor Day
  - River flows
    - Reasons for Releasing from Oroville Reservoir

Benchmark Study Results

– Existing Conditions, SWP Supply

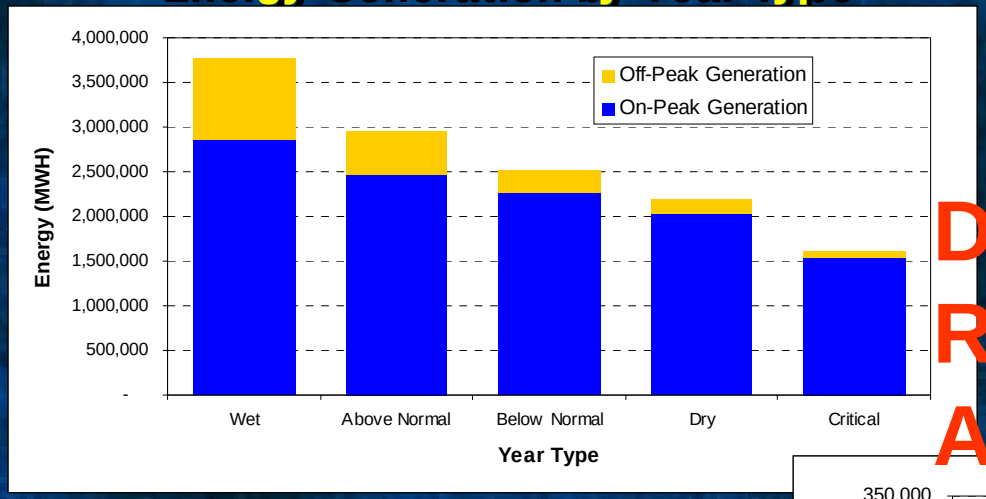


Data by Water Year

Benchmark Study Results

– Existing Conditions, Power Generation

Oroville Facilities Average Annual Energy Generation by Year Type



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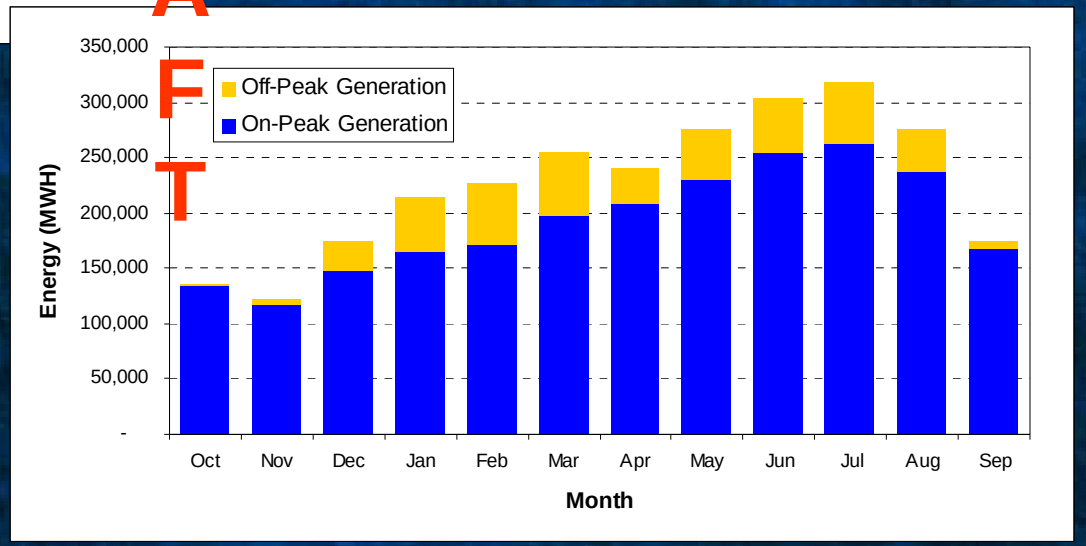
Oroville Facilities Average Monthly Energy Generation



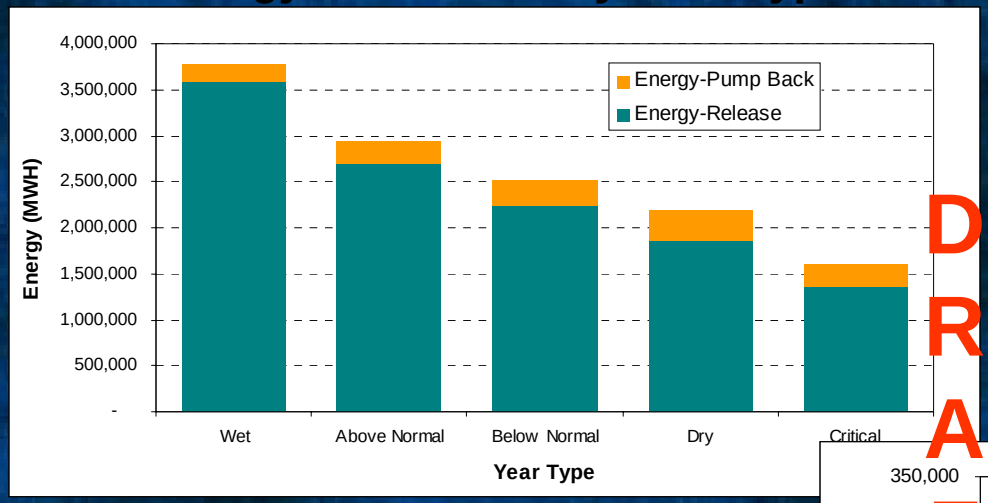
On-Peak vs. Off-Peak

Results of First Iteration between HYDROPS and WQRRS

Benchmark Study Results

– Existing Conditions, Power Generation

Oroville Facilities Average Annual Energy Generation by Year Type



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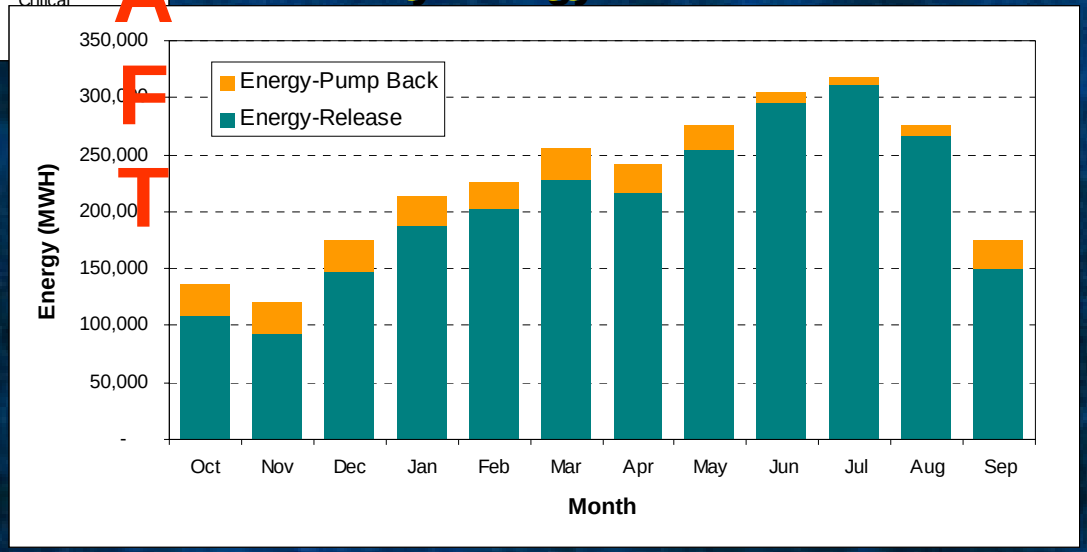
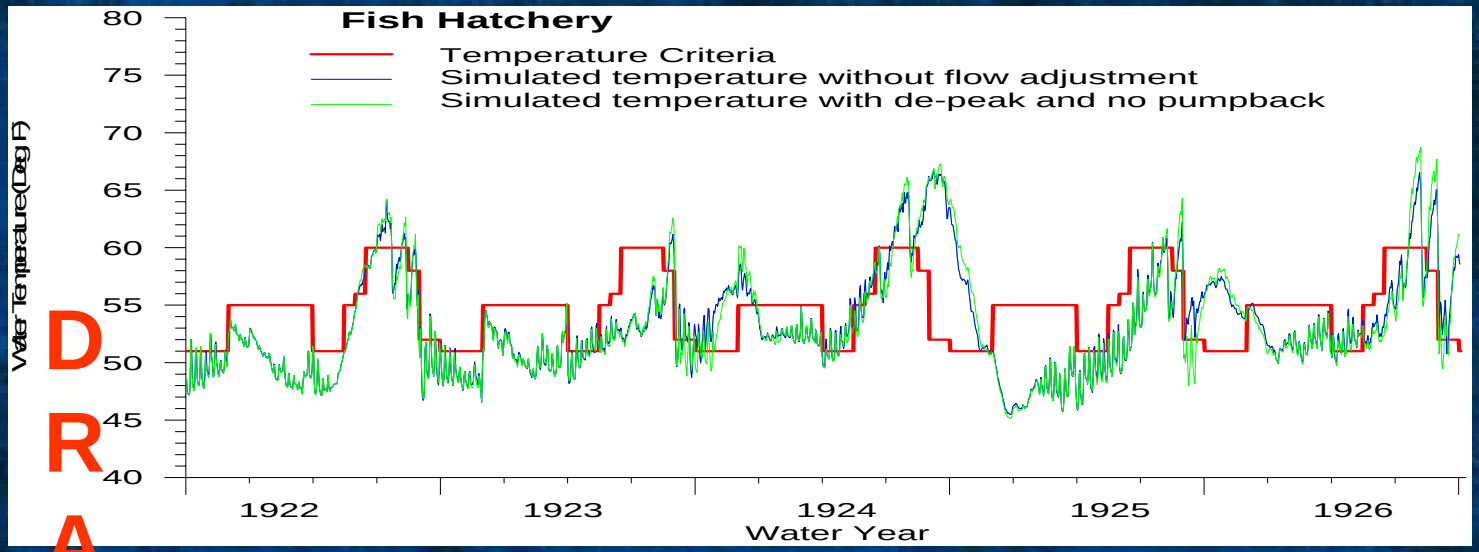
Oroville Facilities Average Monthly Energy Generation

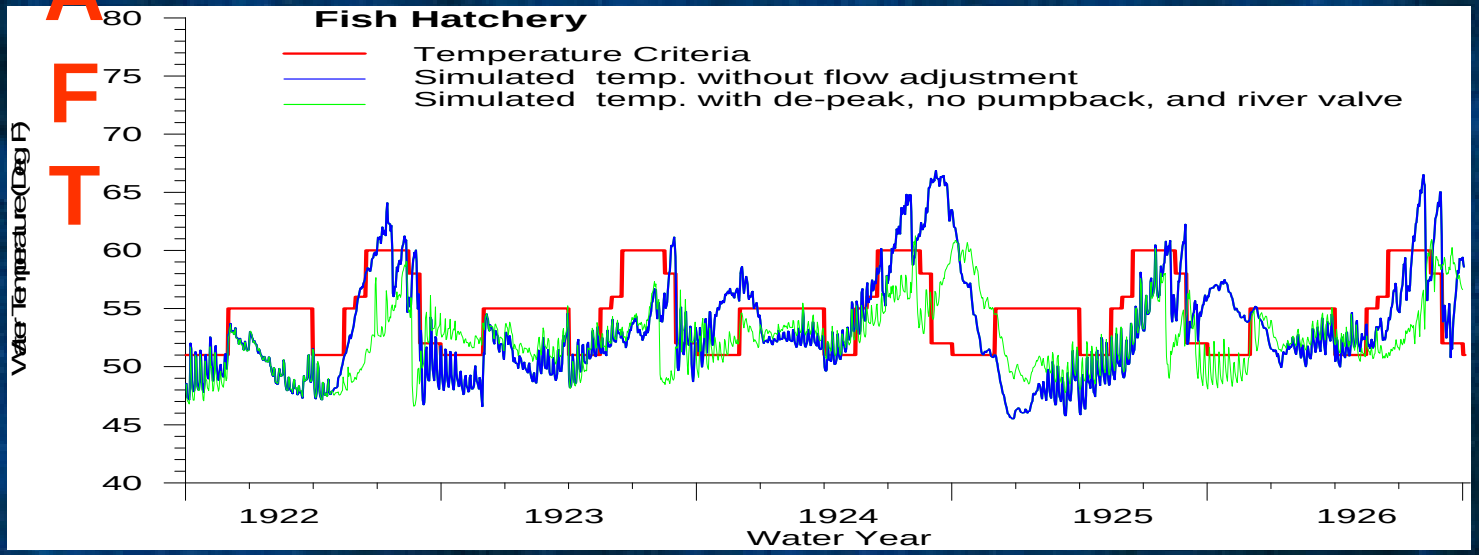


Pumpback vs. Release

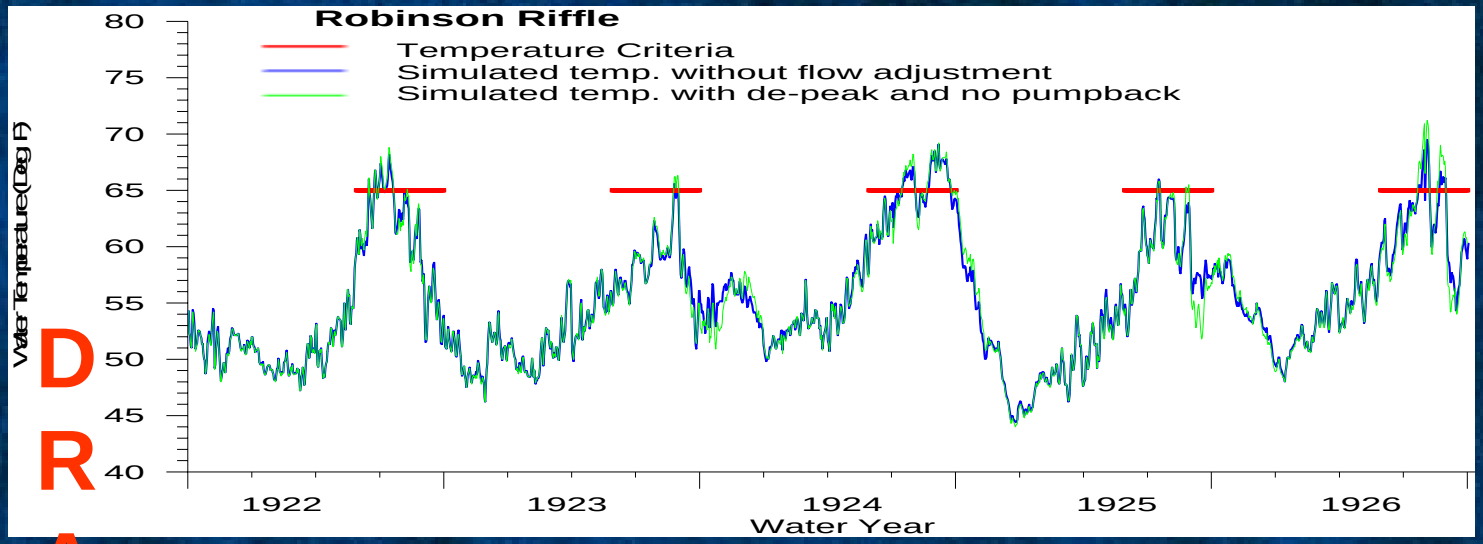
Results of First Iteration between HYDROPS and WQRRS

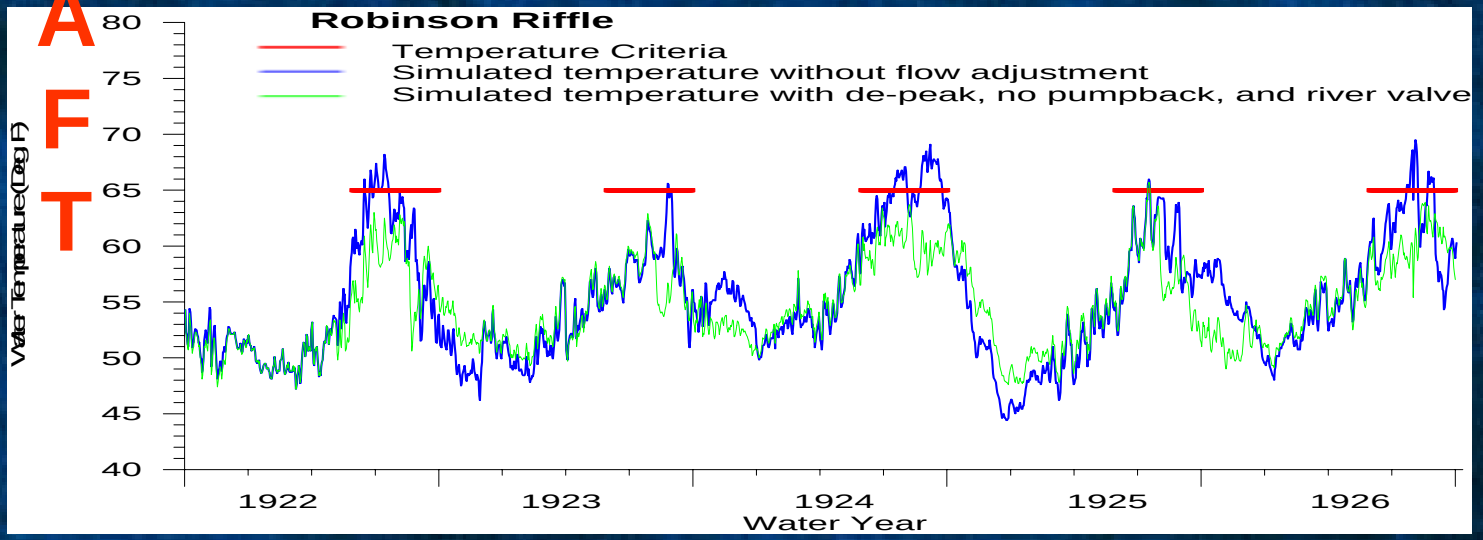
Benchmark Study Results
– Existing Conditions, Temperature





Benchmark Study Results
– Existing Conditions, Temperature





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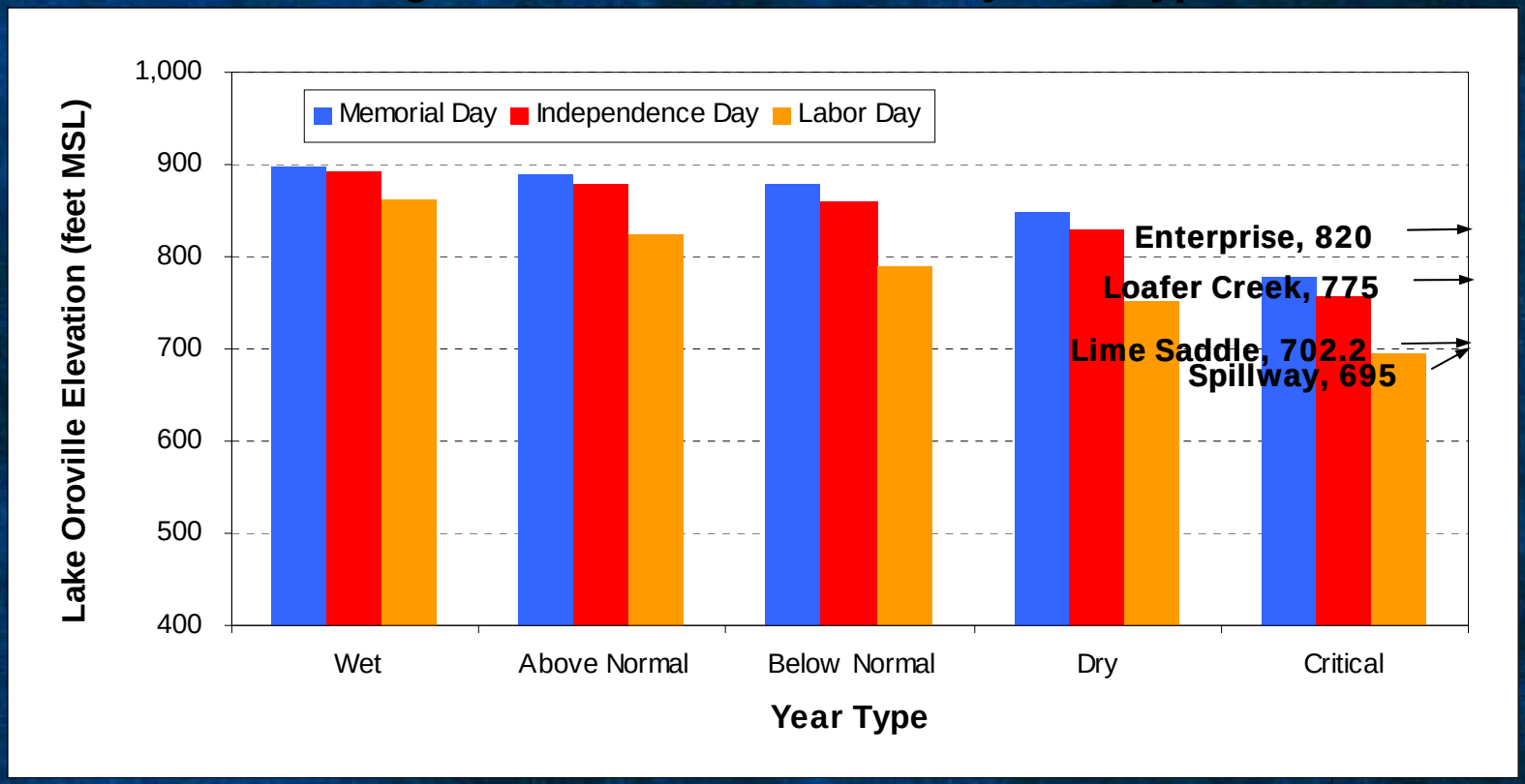
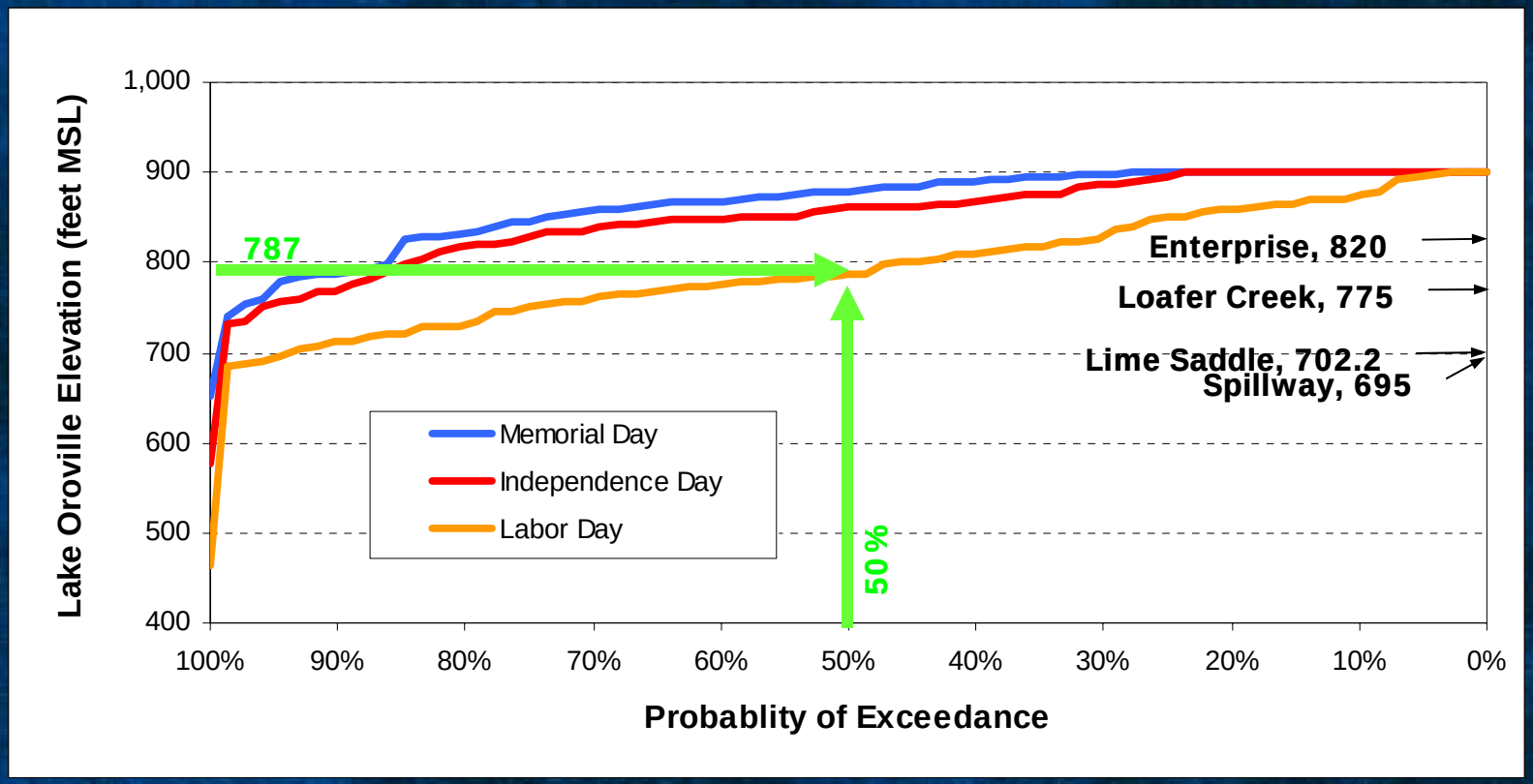
Benchmark Study Results
– Existing Conditions, Reservoir Level

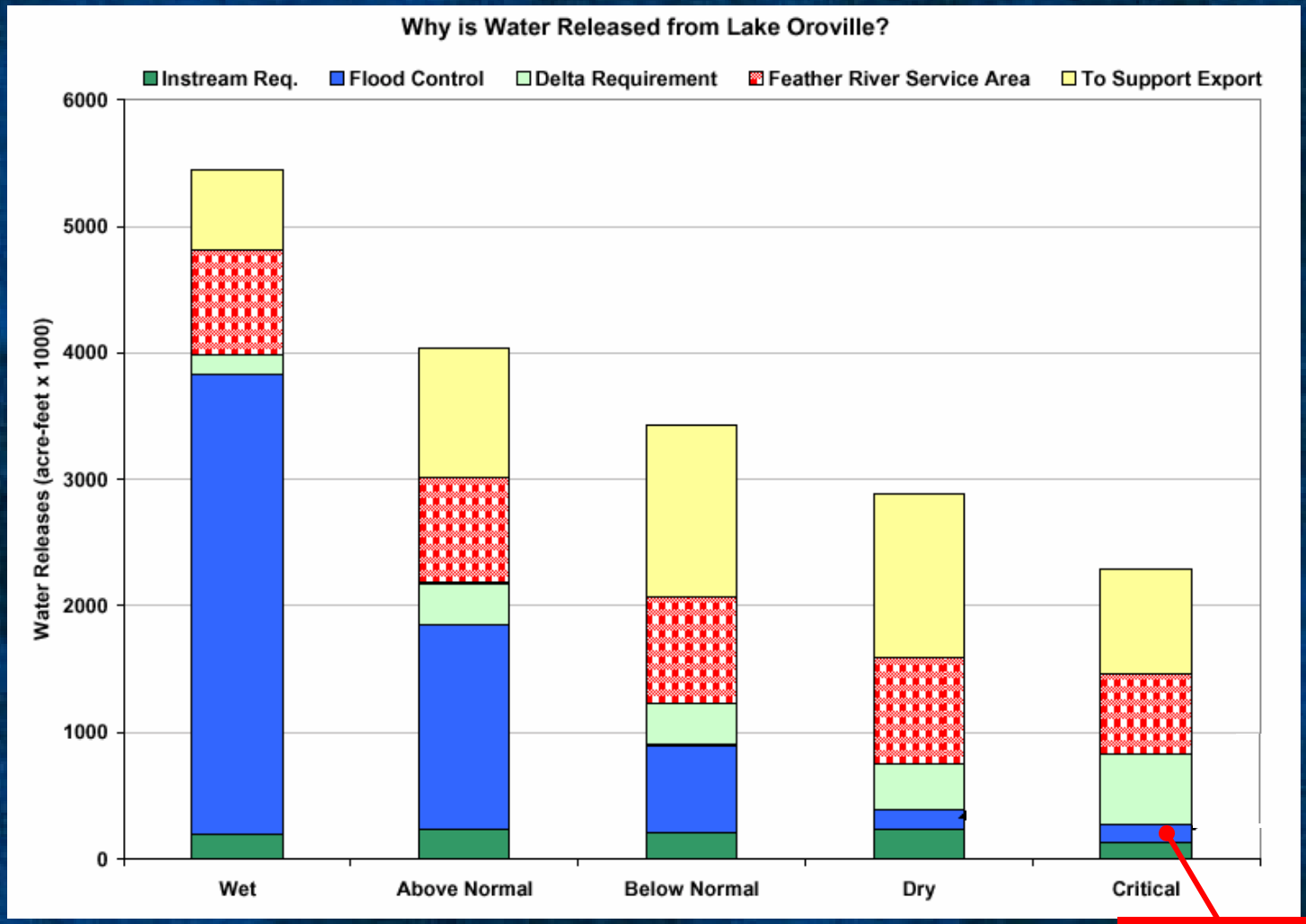


Benchmark Study Results

– Existing Conditions, Reservoir Level



Benchmark Study Results
– Existing Conditions, Oroville Releasing



Now, Let's Take a Break

Workshop Agenda

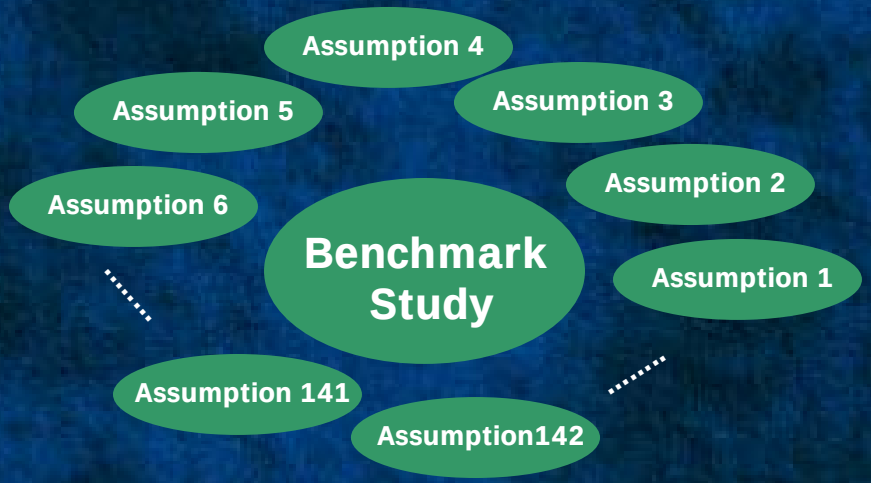
- Welcome and Introduction
- Overview of Modeling Workshop
- Benchmark Study
- Lunch
- Sensitivity Analyses
- Discussion
- Next Steps
- Adjourn

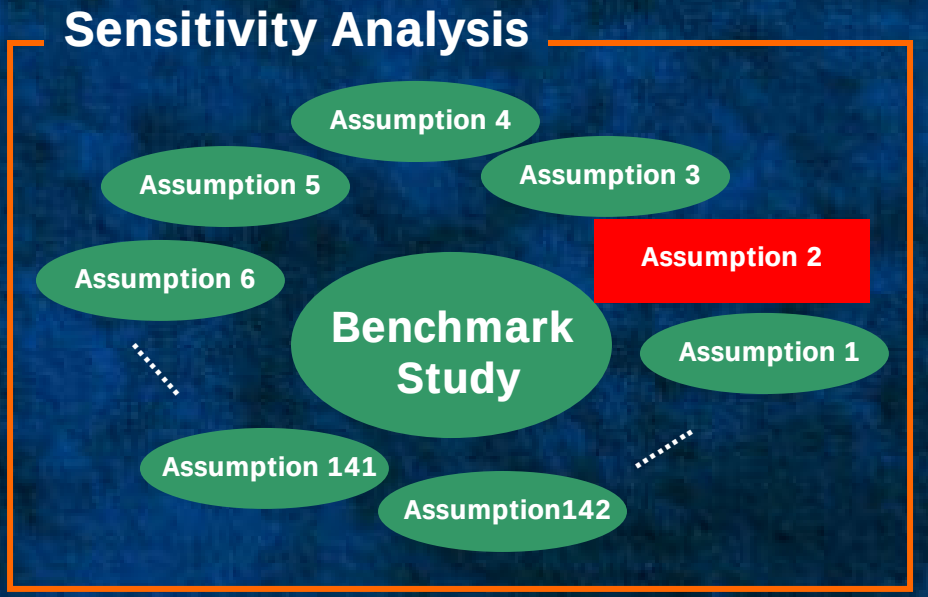
Workshop Agenda

- Welcome and Introduction
- Overview of Modeling Workshop
- Benchmark Study
- Lunch
- Sensitivity Analyses
  - Definition and Development
  - Scenario: Eliminating Pump-Back Operations
  - Scenario: Levels of SWP Demand
  - Scenario: Downstream Extent of Temperature Control
- Discussion
- Next Steps
- Adjourn

Sensitivity Analysis
– Definition

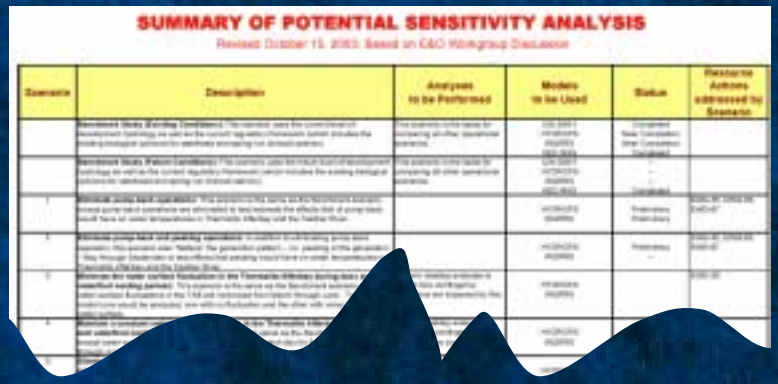
Sensitivity Analysis allows a special interest to explore ranges of potential system responses to controlled changes in operating conditions, derived from Benchmark Study results or from a separate Oroville Facilities-related data or information





Sensitivity Analysis
– Scenario Development

- Development
  - Collaborated effort
  - Support the development of resource actions
  - These scenarios are not alternatives



SUMMARY OF POTENTIAL SENSITIVITY ANALYSIS

Revised October 15, 2003, Based on E&O Workgroup Discussion

Scenario	Description	Analyses to be Performed	Models to be Used	Status	Resource Actions addressed by Scenario